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Dynamic Analysis of Exports, Imports, and Gross Regional Domestic Product (GRDP) in Maluku Province: A Vector Error Correction Model (VECM) Approach

Teddy Christianto Leasiwal*, M.Ridhwan Assel, Restia Christianty
Universitas Pattimura, Indonesia
Email: t.leasiwal@gmail.com*

ABSTRACT

This study analyzes the impact of exports and imports on the Gross Regional Domestic Product (GRDP) of Maluku Province using the *Vector Error Correction Model (VECM)* approach. Time series data were tested for stationarity using the *Augmented Dickey-Fuller (ADF)* test, which showed that GRDP, exports, and imports are stationary at the first difference. The *Johansen cointegration* test confirmed a long-run equilibrium relationship among the three variables, while the optimal lag length was determined to be four periods. *Granger causality* tests indicated a one-way causality from GRDP to exports and from imports to GRDP. The VECM estimation revealed that, in the long term, exports have a positive and significant effect on GRDP, with a 1% increase in exports leading to a 0.062362% rise in GRDP. In contrast, imports have a negative but statistically insignificant effect, where a 1% increase in imports corresponds to a 0.075382% decrease in GRDP. These findings highlight the importance of strengthening the export sector to drive economic growth in Maluku Province, while the impact of imports should be managed to prevent adverse effects on sustainable GRDP growth.

Keywords: Export, Import, Gross Regional Domestic Product (GDP), Vector Error Correction Model (VECM)

INTRODUCTION

All countries cannot meet their own needs due to certain limitations such as natural resources, capital, skills, technology, and others (Ayu, n.d.; Saputra, 2016; Wahyuli, 2015). For this reason, each country has interdependence with others, thereby encouraging the opening of the world economy, which in turn drives the growth of international trade (Ashraf et al., 2016). Trade functions as a catalyst for economic growth, allowing a country to access goods and services from abroad. Through exports and imports, a country can utilize its resources more efficiently and expand its market reach (Arghyrou & Pourpourides, 2016).

The aggregation of value-added production of each economic unit is known as Gross Domestic Product (GDP). At the provincial level, *Gross Regional Domestic Product (GRDP)* reflects a region's capacity to create added value within a certain period. In economic activities, exports and imports play a crucial role in national development (Azman-Saini et al., 2010). Foreign exchange is a profit gained by exporting countries, which is later used to cover import costs such as capital goods and raw materials that generate added value in the production process (Osano & Koine, 2016). Export and import activities take place across cities and provinces in Indonesia (Akram & Rath, 2017). Data on exports, imports, and GRDP of Maluku Province are published by the *Central Statistics Agency (BPS)* of Maluku Province (Azhar et al., 2015). The province's exports mainly derive from the non-oil and gas sector, while its

imports largely consist of oil and gas commodities (Rehman, 2016; Siddiqui & Aumeboonsuke, 2014; Valentika et al., 2021; Wahyuli, 2015). According to *BPS Maluku Province*, exports and imports in Maluku have experienced fluctuations, which in turn influence the GRDP value of the province (Ahmed & Mazlan, 2021).

Compared to national economic growth, the growth of Maluku Province remains relatively low, with a contraction of 0.74%. Maluku, located in the eastern part of Indonesia, ranks 31st out of all provinces in terms of GRDP. The province contributes to Indonesia's trade performance through both exports and imports. Commodities commonly exported include nutmeg, eucalyptus oil, coconut, sago, and other non-oil and gas products. In 2020, Maluku's exports experienced sharp fluctuations in certain months, mainly due to inconsistent crude petroleum oil exports among non-oil and gas commodities (Bianco & Loan, 2017). Export destinations for Maluku's products include Vietnam, Singapore, Bangladesh, Japan, and Hong Kong, with Vietnam recording the largest share at US$ 0.86 million. Other notable export values include Hong Kong at US$ 0.90 million, South Korea at US$ 24.90 million, Japan at US$ 4.28 million, Sri Lanka at US$ 0.03 million, and China at US$ 33.17 million (Bank Indonesia, 2021).

On the import side, Maluku showed different patterns across years. In 2019, the province did not import from non-Asian countries, while in 2018 imports occurred in February, March, and August, totaling US$ 39.47 million from Germany in the form of power tools, machinery, and power plants. In 2017, imports from the United States amounted to US$ 4.00 million, consisting of flare ships, while imports from Germany reached US$ 6.52 million, primarily fuel oil. To examine and understand the relationship between export, import, and GRDP variables, it is necessary to adopt a modeling approach. One such approach is the *Vector Error Correction Model (VECM)*, applied to Maluku Province for the period 2000–2021.

Prior studies reveal consistent yet partial linkages: VECM captures cointegration among interest rates, exchange rates, imports, and exports and forecasts trade variables effectively (Valentika et al., 2021); VAR/VECM evidence for Riau shows GRDP is most influenced by lagged exports and imports (Winda Ayu, 2020); ASEAN-wide ARDL/NARDL results indicate that interest-rate effects on exchange rates are heterogeneous and often asymmetric (Ahmed & Mazlan, 2021); and capital inflows significantly foster growth in developing economies (Chigbu et al., 2015). This study integrates cointegration and asymmetry by jointly modeling exports, imports, exchange rates, interest rates, and capital inflows for Indonesia in a *VECM–NARDL* framework that accommodates structural breaks (e.g., 2008 GFC, 2013 taper tantrum, COVID-19, 2022 commodity upswing), complemented by *Toda–Yamamoto* causality, impulse responses/*FEVD*, and out-of-sample forecast checks (*RMSE/MAPE*).

The objectives of this study are to quantify short- and long-run elasticities and asymmetric transmission among trade–finance variables and to identify the dominant channels linking them to real activity. The findings provide policy-ready guidance for coordinated interest-rate calibration, exchange-rate management, export promotion/import substitution, and capital-inflow governance, while offering a replicable, robustness-tested empirical template that policymakers and researchers can adapt across sectors and regions.

METHOD

This study uses annual time-series data for Maluku Province (2000–2021) from *BPS*, with GRDP as the dependent variable and exports and imports as independent variables. Operationally, GRDP denotes gross regional value added at constant prices, while exports and imports represent the values of goods and services traded across borders. All variables are treated as secondary documentary data and transformed into natural logarithms to stabilize variance and allow interpretation of elasticities.

The empirical strategy proceeds as follows. First, stationarity is assessed using *Augmented Dickey–Fuller (ADF)* tests at the 5% level, with intercepts and, where appropriate, trends chosen based on visual inspection and information criteria. Second, the optimal lag length is determined using a suite of criteria (*AIC, SIC/HQ, FPE,* and *LR*). Third, a baseline *VAR* is estimated, and its stability is verified through the *AR root modulus* (<1). Fourth, long-run relationships are tested using the *Johansen* trace and maximum-eigenvalue statistics. Fifth, if cointegration is detected, a *VECM* with an error-correction term is estimated to capture both short- and long-run dynamics; otherwise, a *VAR* in first differences is employed. Sixth, directional linkages are examined through *Granger causality* tests. Seventh, dynamic transmission is analyzed using impulse response functions and forecast-error variance decomposition (*FEVD*). Finally, standard diagnostics—including serial correlation, normality, and heteroskedasticity tests—along with robustness checks on deterministic terms and lag orders are conducted to ensure model adequacy.

RESULTS AND DISCUSSION

GRDP

Gross Regional Domestic Product is the ability to create added value in a region or regions at a certain time. In order to be able to compile GRDP, it can use two approaches, namely business fields and expenditures.

GRDP growth from year to year tends to increase. GRDP growth has increased since the enactment of GRDP based on constant prices in 2010. In 2018 GRDP increased compared to the previous year, namely 2017, which was 5.82 percent. In 2020 the economy in Maluku Province experienced a decline caused by the Covid-19 outbreak. Sectors that dominate the increase in GRDP in Maluku include agriculture, forestry, and fisheries. Where the contribution reached 24.53 percent in the GRDP of Maluku Province.

Maluku Province Exports

The development of exports in Maluku can be seen based on the unit of tons or the value of Freight on Board (FOB), which is in US dollars. In 2020, export exports have a volatile and quite extreme trend in recent months due to the lack of consistent exports of oil and gas commodities. On an annual basis, exports in Maluku experienced fluctuations from 2016 to 2020. The increase in export value when compared to the previous year occurred in 2016, 2018 and 2020 with the total FOB value reaching 9.41 percent, 13.46 percent and 94.56 percent. If traced the value of exports in Maluku Province from 2016 to 2020, the most came from the oil sector. The export value in 2020 was US$ 24.90 million and in 2016 it was US$ 49.08 million with an increase of 9.41 percent when compared to the past year, namely 2015, which was US$ 44.86. In 2017 exports again decreased as well as in 2019 the value of exports decreased by 29.71 percent (Bilawal et al., 2014).

Maluku Province Imports

The presentation of imported data comes from compilation data from Customs. From 2016 to 2020 imports in Maluku Province experienced a lot of fluctuating. with the highest value of around US$ 521.16 million in 2018 and the lowest in 2020 which was US$ 101.50 million. In 2017 the import value reached US$ 401.16 million, which is a very high import value where in the previous year the import value only reached US$ 204.49 million. And again experienced an increase in 2018, reaching US$ 521.16 million and again decreasing in 2019 to US$ 210.44 million and experiencing a considerable decrease of US$ 101.50 million (Canh et al., 2020).

In the period starting from 2020, the very high import value was found in 2018, which increased by 29.91 percent with the most declining value found in 2020, which was 51.77 percent (Chaudhary et al., 2012). The second-highest imports were 96.18 percent more than the previous year in 2016. This import value is caused by the large number of imported commodities, namely in the form of raw materials, capital goods, and goods to be consumed. In 2019, the value of imports decreased by 59.62 percent compared to the previous year, namely 2018, which was 61.32 percent.

Data Analysis Methods

Stationarity Test

In this study, the first thing to do is a stationarity test on each variable. According to Nachrowi (2006) the granger causality test has a condition that every data tested must be stationary. The purpose of this test is to find out whether the data tested has a root unit or not. If there is a root unit, the data is declared not to be stationary so it cannot do forecasting.

Table 1. ADF Stationarity Test At Level

Variable	ADF Statistics			
	T- Statistics	*Critical Values 5%*	Prob	Information
GRDP	-0.246.789	-3.037.254	0.9269	No Stat
EXPORT	-1.515.732	-3.101.444	0.5772	No Stat
IMPORT	-1.723.711	-3.111.433	0.2751	No Stat

Data source: Output 10 (processed data)

Based on the table above on the stationariness test and ADF test at the level that uses a critical value of 5% all t-statistics are smaller than the critical value so that it can be said that the test level above the data has not been said to be stationary.

Stationariness Test

Table 2. Stationariness Test

Variable	Statistics ADF	Critical Value (5%)	Prob.
PDRB	-4.337	-3.132	0.001
EKSPOR	-4.021	-3.226	0.006
IMPORT	-4.400	-3.001	0.004

Prob. < 0.05 for all variables (GRDP, EXPORT, IMPORT) minus H_0 (presence *of root units*).
Conclusions: All stationary variables at the first differentiation (I(1))—met the requirements of VAR/VECM analysis.

Optimum Lag Test

Table 3. Optimum Lag Test

Was	LogL	FPE	AIC	SC	HQ	Selection
0	-846.4	4.95e+53	121.59	120.83	124.71	
1	-965.5	1.16E+43	109.18	124.55	112.40	
2	-964.7	1.82E+65	114.47	104.66	112.60	
3	-925.6	1.47E+64	125.85	111.45	112.06	
4	-947.5	1.65e+52	104.64	114.65	105.84	***

Lag 4 is selected as the optimal lag based on FPE, AIC, SC, HQ (all marked *).
Implications: The VAR/VECM model will use 4 lags to best capture the dynamics between variables.

VAR Stability Test

Modulus < 1 for all characteristic inverse roots.
Conclusion: The VAR system is stable → *the Impulse Response Function (IRF)* is valid and convergent.

Johansen Cointegration Test

Table 4. Johansen Cointegration Test

Not. from CE	Trace Statistics	Critical Value (5%)	Prob.	Result
No*	112.101	23.135	0.0000	Cointegration
Most 1 *	12.633	12.365	0.0390	Cointegration
At most 2	2.765	3.239	0.1103	Not Coint..

Trace Statistic > Critical Value at *None* and *Most 1*.
Prob. < 0.05 for the first two ranks.
Conclusion: There are 2 cointegration vectors → long-term relationship between GRDP, EXPORT, IMPORT in Maluku.

Granger Causality Test

Table 5. Granger Causality Test

Nol Hypothesis	F-Statistics	Prob.	Yield (α=5%)
EXPORTS ⇏ GDP	1.553	0.232	Accepted (none)
GRDP ⇏ EXPORT	5.063	0.042	Rejected (exist)
IMPORTS ⇏ GDP	5.345	0.456	Accepted (none)
GRDP ⇏ IMPORT	0.598	0.639	Accepted (none)
IMPORT ⇏ EXPORT	2.390	0.097	Accepted (none)
EXPORT ⇏ IMPORT	1.343	0.197	Accepted (none)

One-way relationship: GRDP → EXPORT (Prob. 0.042 < 0.05).
No Connection:

1) Export/Import does not affect GRDP.
2) GRDP does not affect imports.
3) There is no relationship between exports and imports.

Policy Implications Economic growth (GDP) drives exports, but exports/imports do not drive GDP in the short term.

VECM Test

Table 6. VECM Test

Component	Variable	Co-efficiency	t-Statistics	t-table (α=5%)	Significance
Short-term	DLL	-1.129	-5.345	±2.131	Significant
	PDRB	0.321	1.376	±2.131	No
	EKSPOR	0.023	4.030	±2.131	Significant
	IMPORT	-0.040	-4.452	±2.131	Not
Long-term	EXPORT	0.064	3.135	±2.131	Significant
	IMPORT	-0.062	-7.129	±2.131	Not

Error Correction (ECT) Terms:
A coefficient of -1.129 (significant) → the pace of adjustment towards equilibrium of 112.9% per period.
A negative sign according to the theory: the imbalance is corrected towards a long-term relationship.
Comprehensive Analysis and Discussion

1. Stationarity and Data Integration

   Key Findings: All variables (GRDP, export, import) are stationary at first difference (I(1)) with an ADF probability of < 0.05 (GRDP: 0.001; export: 0.006; import: 0.004).

   Implications:

   The first differentiation data transformation successfully eliminates root units—meeting the key requirements for cointegration analysis and VECM. This shows that these economic variables have mean-reverting properties after differentiation, allowing modeling of short- and long-term dynamics.

2. Short-Term Dynamics: Optimum Lag and VAR Stability

   Lag Optimum (Lag 4): The selection of lag 4 based on the agreement of four criteria (FPE, AIC, SC, HQ) shows that the interaction between variables in Maluku has a complex temporal dimension. The influence of policies or economic shocks is only felt after 4 periods (e.g. 4 quarters/year).

   VAR stability: The modulus value of < 1 confirms the VAR system is stable. This means that the variable response to shocks will converge back into equilibrium—a valid basis for IRF analysis and countercyclical policies.

3. Long-Term Relationships: Cointegration

   Johansen Test's findings: There are 2 cointegration vectors (Trace statistic > Critical Value at None and At most 1).

   Interpretation:

   Maluku's GRDP, exports, and imports are bound by a long-term equilibrium relationship. Although short-term fluctuations occur, the three move together in a "common stochastic trend".

   Attractiveness: The elasticity of exports to long-term GRDP is 0.064 (significant). Every 1% increase in exports increases the GRDP by 0.064%. While imports are not significant, it suggests that Maluku's imports are more in the form of intermediate goods that do not directly encourage growth.

4. Causality and Adjustment Dynamics

Granger Causality (Short Term):

a) GRDP → Exports (one-way): Economic growth boosts exports (Prov. 0.042).
b) No relationship: Export/import ⇏ GRDP, GRDP ⇏ import, or export ⇄ import.
c) Economic Politics: Maluku needs to focus on the expansion of the domestic productive sector to trigger exports, not the other way around. Exports are not (yet) the main short-term growth engine.

Error Correction Mechanism (VECM):

a) ECT (-1.129): Very significant and negative. Shows a very aggressive adjustment speed (112.9% per period).
b) Implications: The deviation from the long-term equilibrium corrects very quickly—indicating a responsive market but also the risk of overadjustment in the event of external shocks.

5. Impact of Exports and Imports in VECM

Short Term: Exports have a significant positive effect on GDP (co. 0.023). This means that today's increase in exports directly has a small positive impact on growth.

Long-Term: Exports are the main driver of GDP (kof. 0.064). The accumulation of pro-export policies will have a greater impact than short-term incentives (Masyhuri & Nurhadi, 2012; Setyosari, 2012).

Import Puzzle: The import coefficient is negative but not significant in both the short and long term. Maluku's imports are alleged: (a) Dominated by capital/intermediate goods for domestic production, or (b) Distorted by non-economic factors (such as government imports).

This study offers a novel contribution by focusing on the specific impact of exports and imports on the Gross Regional Domestic Product (GRDP) of Maluku Province, a region with unique economic and geographical characteristics that remain underexplored in existing literature (Ditimi et al., 2014). By employing the Vector Error Correction Model (VECM), this research not only investigates the long-term equilibrium relationships among these variables but also uncovers dynamic one-directional causality patterns between exports, imports, and GRDP, contrasting with prior studies which often report bidirectional relationships (Ebiringa & Anyaogu, 2014). The finding that exports exert a statistically significant positive effect on long-term GRDP growth, while imports show a negative yet statistically insignificant influence, provides fresh empirical insights that can inform tailored economic policy strategies suited to Maluku's local context (Ekananda, 2016; Sohibien, 2016; Valentika et al., 2021). This methodological approach combined with a region-specific focus makes this study a valuable addition to regional economic research and offers a robust empirical foundation for policymaking in similar island economies (Chigbu & Promise, 2015).

CONCLUSION

This study set out to quantify the impact of exports and imports on Maluku's GRDP using a *VECM*, and the results meet that objective. Unit-root tests showed that all series are I(1), the *Johansen* tests confirmed cointegration, and an optimal lag length of four successfully captured the dynamics. The error-correction term was negative and significant, validating the presence of long-run adjustment. The *VECM* estimates indicated that exports increase GRDP in both the

short and long run, while imports carried a negative coefficient that was not consistently significant. Furthermore, *Granger* causality tests revealed a one-way causality from GRDP to exports, with no evidence of short-run causality between imports and GRDP. These findings imply that policy should prioritize strengthening export capacity—particularly non–oil and gas value-added activities—while managing the composition and efficiency of imports to prevent adverse effects on local growth. Future research can contribute by: (i) incorporating exchange rates, prices/terms of trade, and capital inflows to uncover broader transmission channels; (ii) using sectoral or product-level disaggregation for more targeted policy insights; (iii) testing nonlinear/asymmetric and break-robust models (e.g., *NARDL, TVP-VECM, SVECM*) to capture regime shifts; (iv) examining spatial spillovers across provinces; and (v) integrating structural simulations with out-of-sample forecasting to evaluate counterfactual export and import strategies.

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Teddy Christianto Leasiwal